The Residual Bi-2212 Intergrowth Distribution in High-J_c Tapes and its Origins in the in-situ Conversion Process

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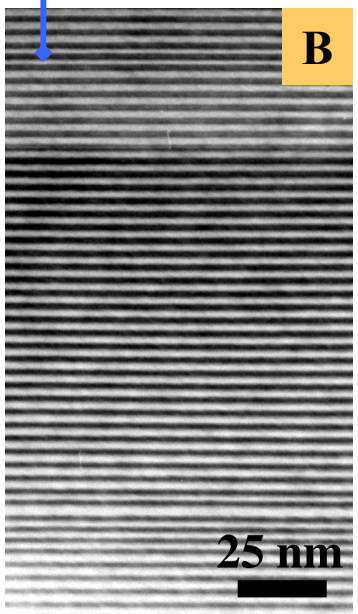
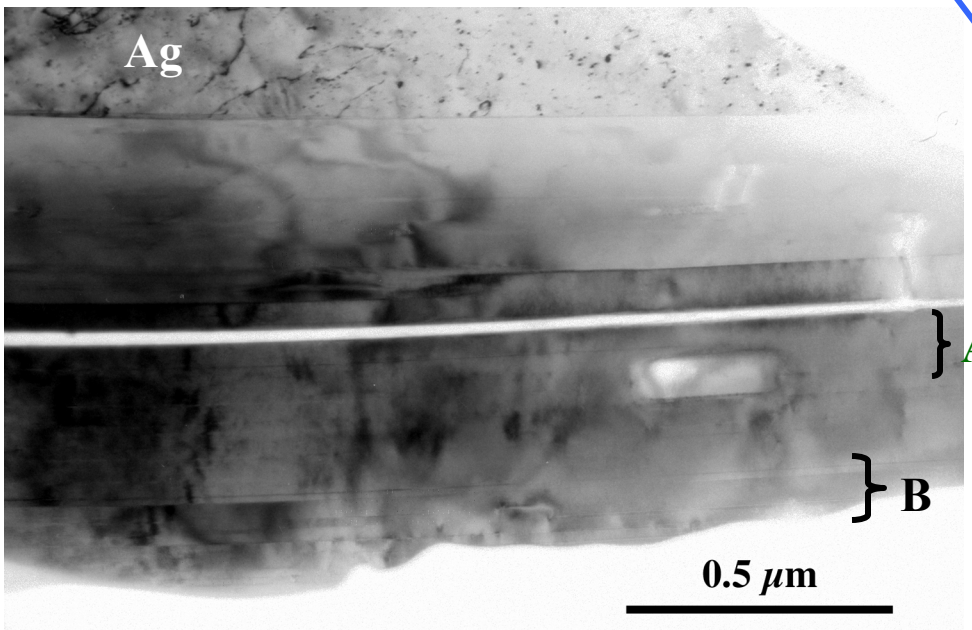
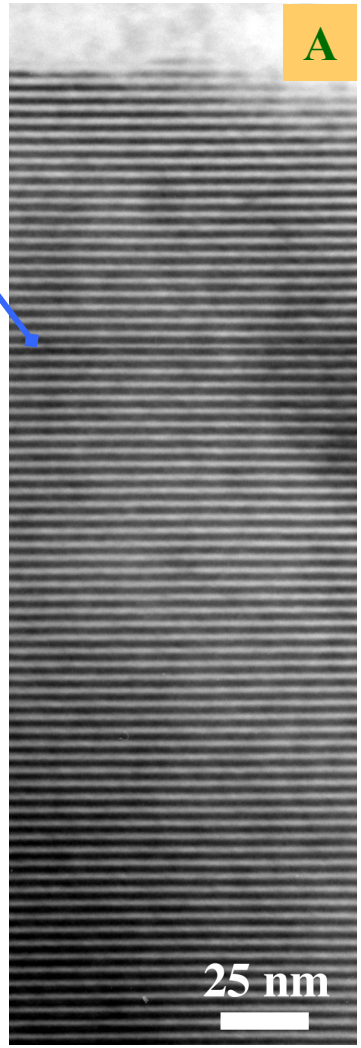
Only the Bi-2223 grain next to the silver sheath was free or nearly free of Bi-2212 intergrowths. (FY2002)

- Spatially non-uniform distribution of intergrowths.
- AMSC production tape with AHT (post anneal) I_c = 163 A, J_c(S.F., 77K) = 47.7 kA/cm^2



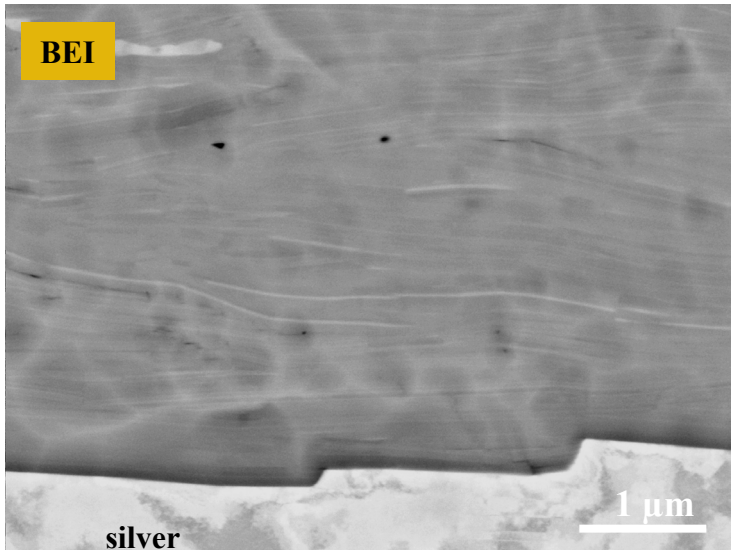


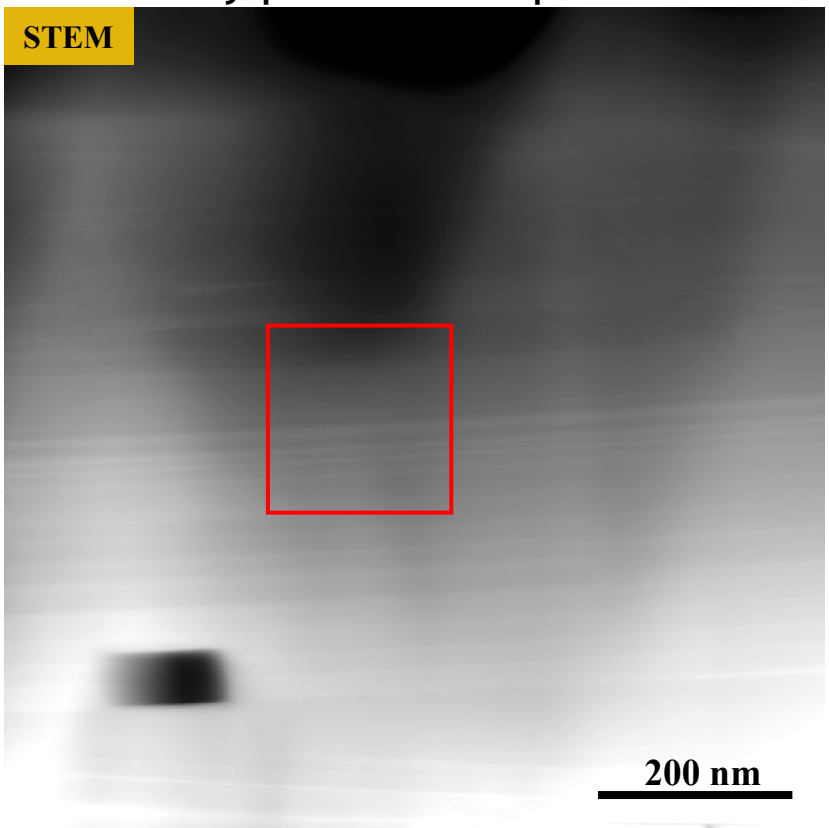


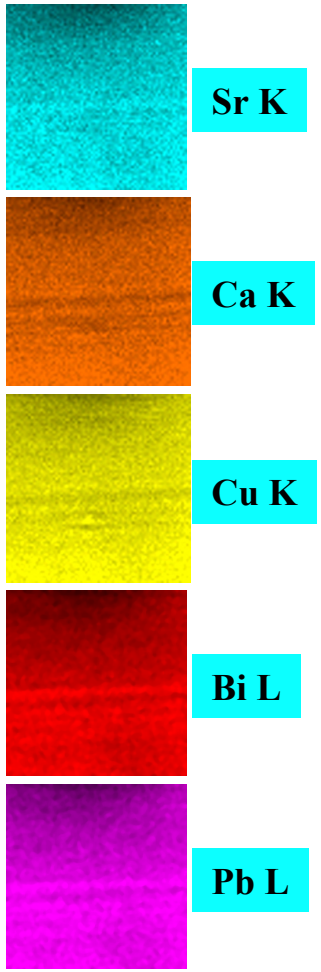
} Bi-2234/Bi-2212 intergrowths

SEM and STEM reveal significant amounts of residual Bi-2212 in the very high-J_c sample (27 kA/cm^2, 77K, 0.1 T)

- STEM imaging and mapping confirm the SEM backscattered images that show Bi-2212 distributed throughout the filament.
- Significant amounts of Bi-2212 left in fully processed tapes.



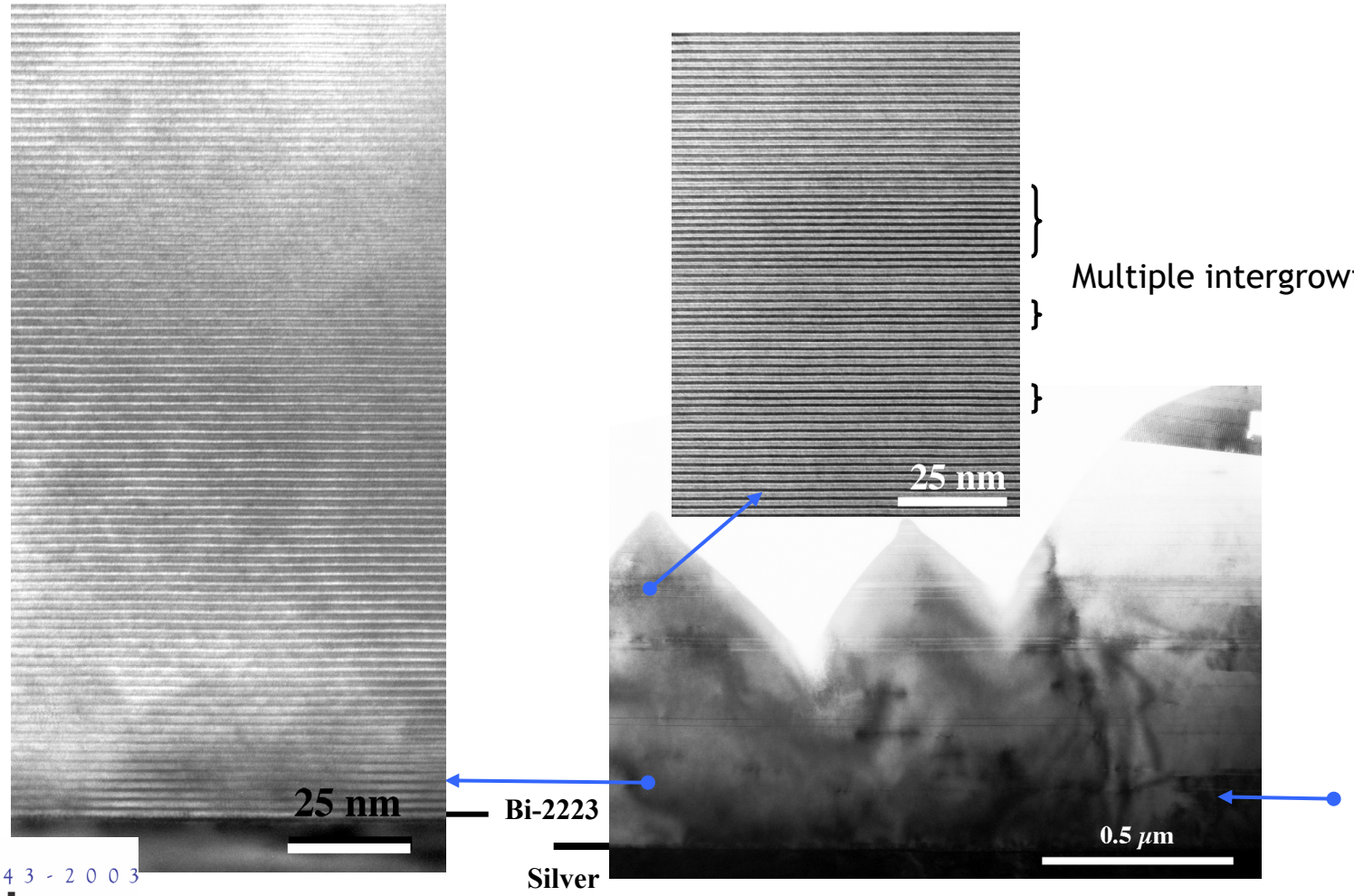




AMSC multifilamentary tape processed at UW with OP post anneal with J_c(0.1T, 77K) = 27 kA/cm^2

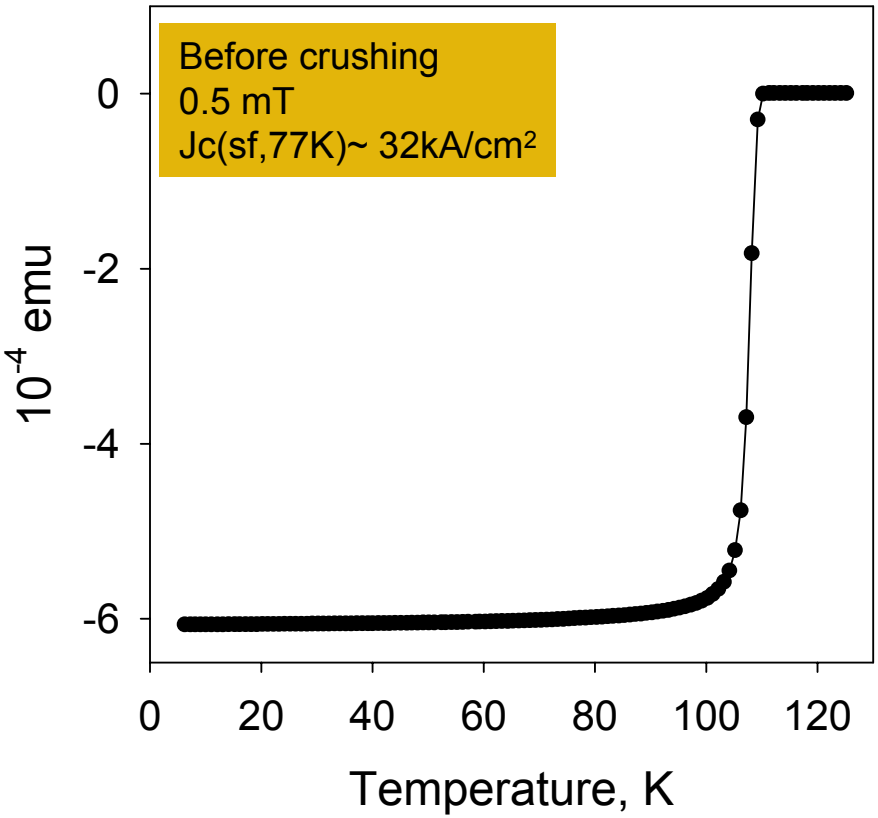
Although OP processing has pushed J_c above 30 kA/cm^2 (0.1T, 77K), a significant population of Bi-2212 intergrowths remains.

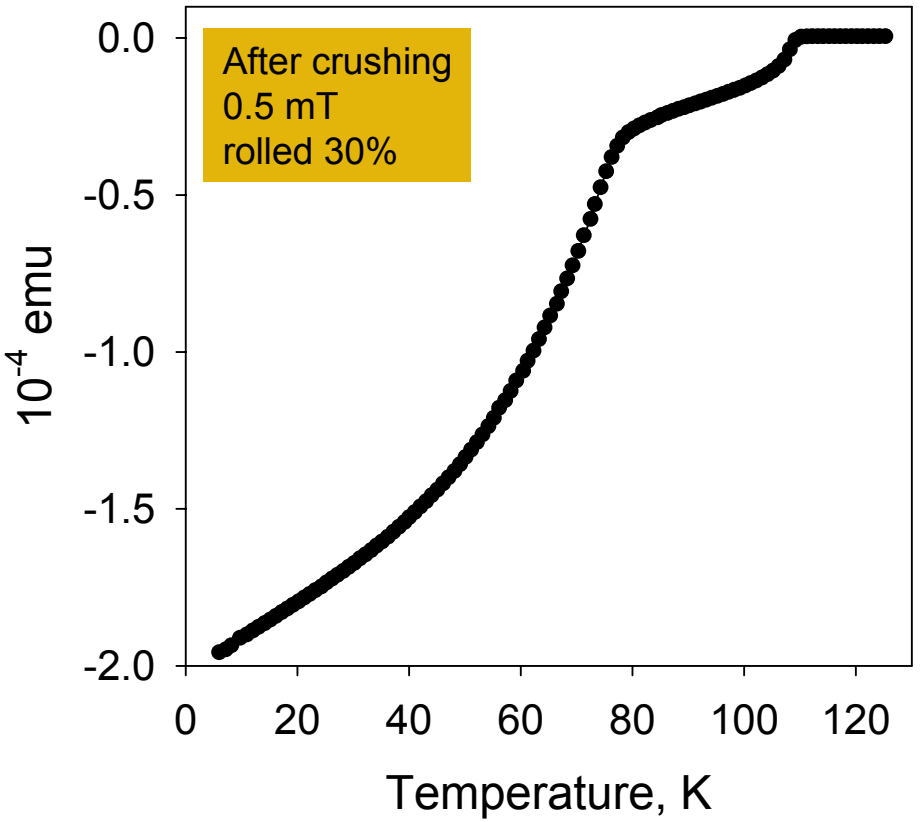
- The grain next to the silver sheath is free of Bi-2212 intergrowths; grains further into the Bi-2223 filament contain Bi-2212 in variable amounts and shapes.



Crushed SQUID magnetization test supports this microstructural shell model of the Bi-2223 filaments

- Shell of well-formed Bi-2223 coats the inside of the silver sheath.
- Bi-2212 intergrowths and small grains can be found everywhere else in the filament.
- Material segregation from conversion process leaves or traps "unreacted" material in the filament centers.

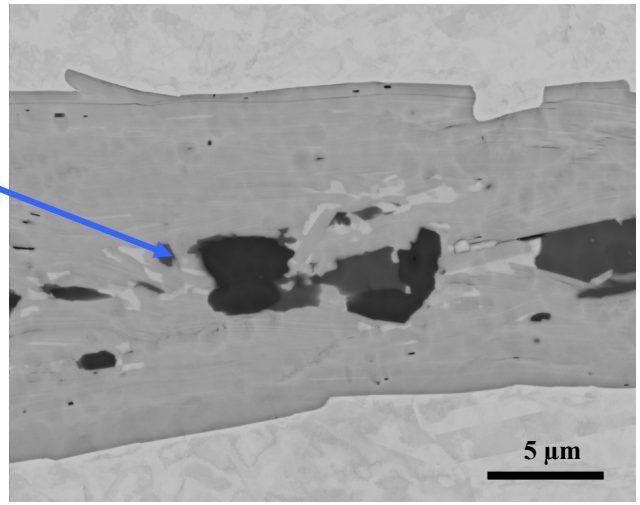


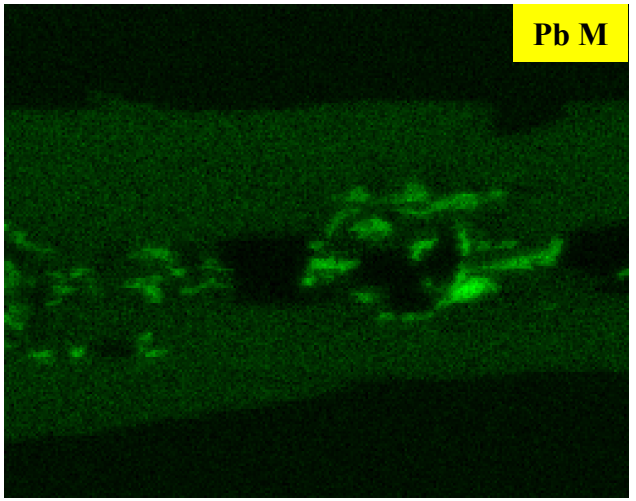


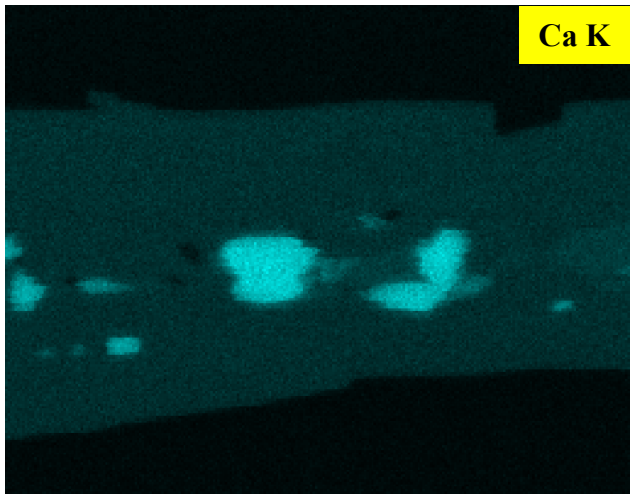
UW SQUID test

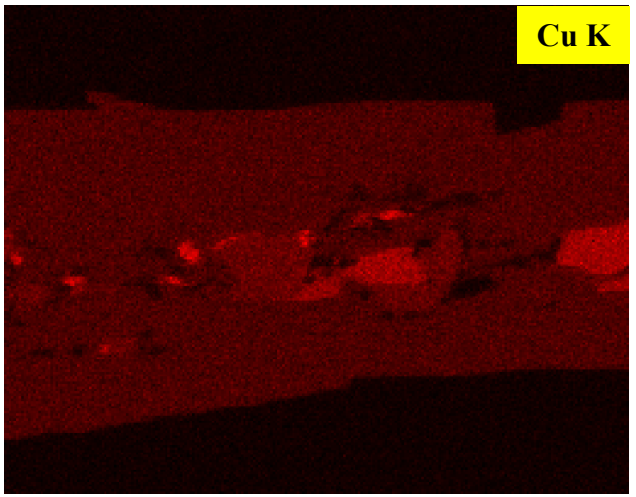
"Excess" material that could be used to convert residual Bi-2212 into Bi-2223 is trapped in the filament centers after full processing.

- Residual phases of the 14-24 AEC, 2:1 AEC, and the Pb-rich 3221 phase in the middle of the filament.
- Entrapment of Bi-2212 within Bi-2223 grains reduces the efficiency of conversion in the filament centers.





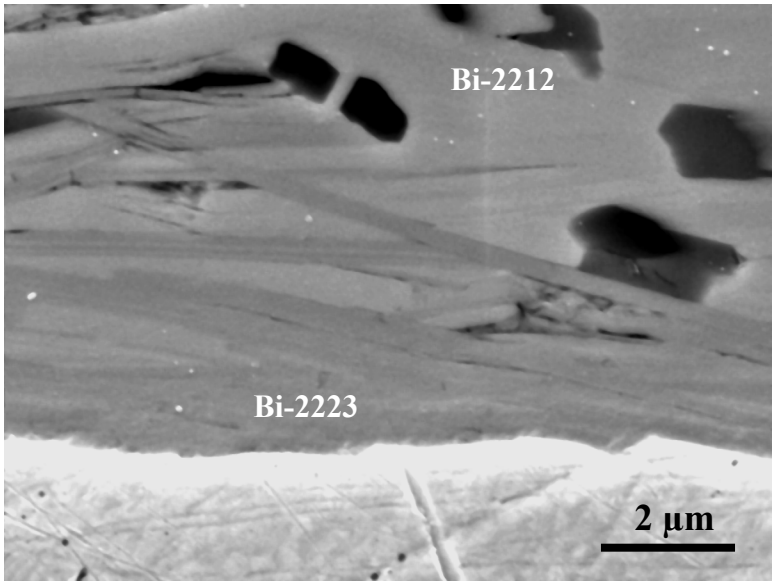




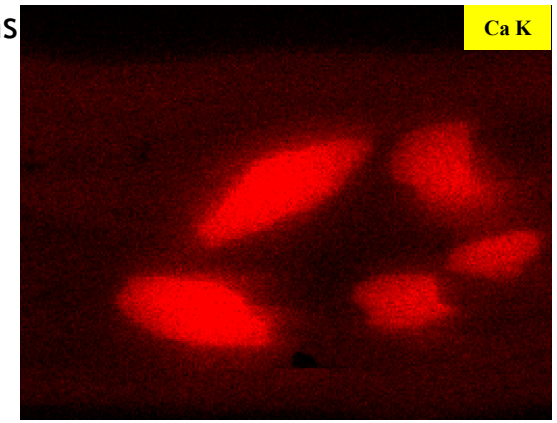
AMSC multifilamentary tape processed at UW with an OP Post Anneal
J_c(0.1T, 77K) = 27 kA/cm^2

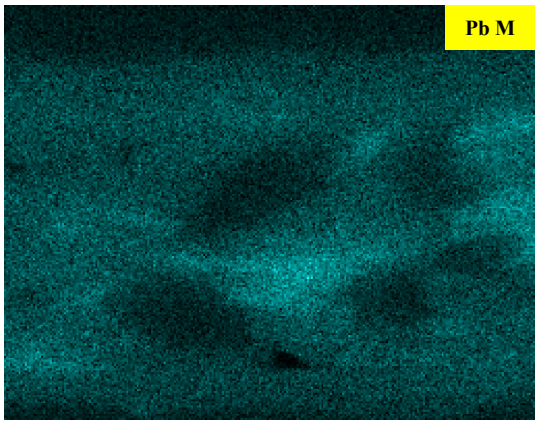
The 2212 to 2223 conversion process produces compositional inhomogenities across the filaments right from its early stages

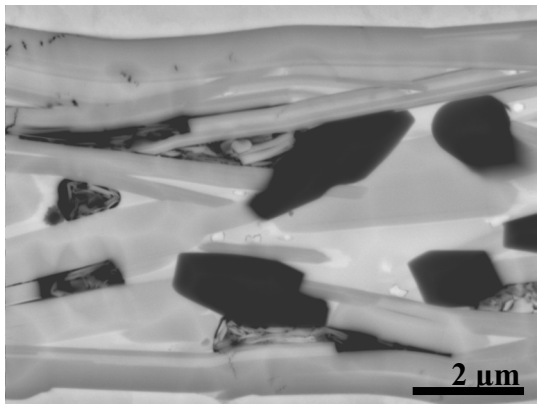
- Preferential growth from the silver combined with anisotropic growth rates define a growth front which rapidly decays into a jumble of Bi-2223 grains protruding into the filament center.
- Bi-2212 trapping by growing Bi-2223 grains

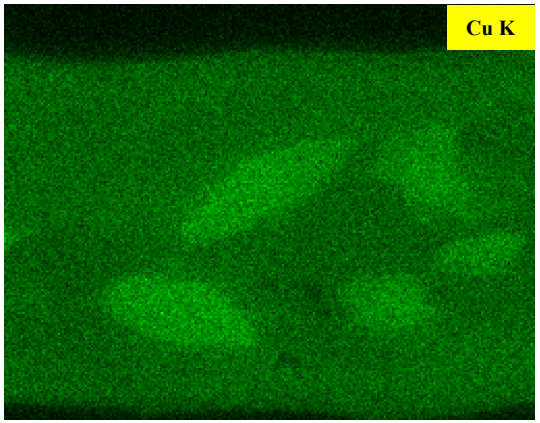


AMSC Bi-2223 tape after 6 hours at 825˚C in 8%O_2.









AMSC Bi-2223 tape quenched in oil after 640 min at 827˚C in 8% O_2.

The distribution of residual Bi-2212 intergrowths within the grains starts with the Bi-2223 precipitation process from the partial melt.

- Intergrowths in the Bi-2223 grains are continuous and their density is directly proportional to the distance from the liquid phase.
- The conversion process ultimately determines the overall distribution of residual Bi-2212 in fully processed tapes.